CHALLENGES INHIBITING MALARIA AID IN THE DEMOCRATIC REPUBLIC OF THE CONGO

An Undergraduate Research Scholars Thesis

by

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ABSTRACT

Challenges Inhibiting Malaria Aid in the Democratic Republic of the Congo

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The Democratic Republic of the Congo (DRC) encompasses 10% of the approximate 407,000 annual malaria-related deaths in Sub-Saharan Africa (WHO, 2017). While this number has not gone unnoticed by the international community, factors such as the lack of infrastructure and socio-economic turmoil impair timely and cost-effective malaria prevention and treatment access. In the DRC, an information gap exists between the existing malaria aid supply chain and an effective decentralized model that takes into account a more thorough view of the factors inhibiting supply chain effectiveness and efficiency (Village Reach, 2015). This gap manifests itself in issues ranging from difficulties in monitoring and transporting malaria commodities to quality assurance of the aforementioned products. The current method of supply chain design relies on imperfect information that does not account for the majority of challenges; not focusing on the holistic spectrum of issues results in a narrow-focused methodology that ultimately hinders effective aid. This research seeks to bridge this gap and improve the current approach by creating a detailed list of factors inhibiting the current success of cost-effective long-term malaria aid in the DRC while focusing on the distribution of effective aid. Employing a qualitative knowledge-based interview with subject matter experts alongside a semantic analysis

in conjunction with a literature review, this research brings together the factors and conditions that inhibit, or increase the cost of, malaria prevention and treatment efforts within the DRC in an effort to create a single comprehensive point of reference. This two-pronged approach focuses on the creation of an aggregated analysis encompassing external and internal issues juxtaposed with preventative and treatment measures, investigating six categorical issues known to undermine humanitarian aid efforts: infrastructural aspects, financial aspects, health structure aspects, organizational aspects, political aspects, and socio-economic aspects. The aforementioned multidisciplinary method shifts the argument to then investigate these issues as a product of culture; supply chain has the unique ability to solve these problems by focusing on the timely cost-effective transportation of the necessary products while considering the inner-workings of the nation and cultural idiosyncrasies. The aim of this research is to streamline humanitarian aid by eliminating the iterant data accumulation processes of consulting numerous data sources and replicating existing research in order to factor in most known variables to determine a more holistic view of supply chain improvement in the DRC. The results of the study demonstrate the interrelation between supply chain and non-supply chain issues, providing key insight to malaria aid organizations on the spectrum of challenges effecting the DRC malaria commodity supply chain and assisting in creating a holistic approach to reduce malaria-related mortality.

NOMENCLATURE

ACT	Artemisinin-based Combination Therapy
CITI	Collaborative Institutional Training Initiative
CDR	Centrales de Distribution Régionales
DRC	Democratic Republic of the Congo
HSR	Human Subjects Research
HMIS	Health Management Information Systems
NGO	Non-Governmental Organization
RDT	Rapid Diagnostic Test
WHO	World Health Organization
PMI	President's Malaria Initiative

CHAPTER I

INTRODUCTION

Often transmitted through the bite of female *anopheles* mosquitoes, malaria is a curable and preventable infectious disease caused by unicellular organisms termed *plasmodium*. Although five species of *plasmodium* exist, *plasmodium falciparum* accounts for a vast preponderance of malaria transmissions globally (WHO, 2016). Once malaria transmission occurs, the host will begin displaying flu-like symptoms and paroxysm after 10 – 28 days, although in some cases symptoms may remain dormant for months or years. In geographic locations where malaria is pervasive, individuals can, albeit rarely, live their whole lives without serious complications; most victims, however, exhibit significant malaria-induced maladies, sometimes resulting in death. In 2016 alone, an estimated 216 million infections of malaria were reported across 91 countries, resulting in approximately 445,000 deaths (WHO, 2017). Although malaria transmissions occur across the world, the global malaria burden rests heavily on Africa, accounting for a disproportionate 90% of the malaria-related deaths (WHO, 2017). Of the 91 countries that have yet to eradicate malaria, the DRC ranks third in the number of malaria cases annually (Uganda ranks first at 10.3 million cases per year and Ghana at 8.8 million cases) and experiences almost 45,000 malaria-related fatalities per year (Pariona, 2016 and WHO, 2017). While malaria is pervasive throughout both Uganda and Ghana, the DRC provides a distinct set of factors stemming from cultural issues caused by both political unrest and a complicated history of colonization and civil war. These problems ultimately create a unique situation that allows the perpetuance of high levels of malaria. According to the Malaria Operational Plan (USAID, 2017) not only are approximately 32% of outpatient visits directly attributable to

malaria in the DRC, but 36% of deaths are caused by malaria-related illness. According to the 2018 U.S. Aid report, only approximately 30% of Congolese have access to medical aid; furthermore, the dearth of accessible health care precipitates these entirely preventable deaths (U.S. Aid, 2018a).

As seen in Figure 1, depicting the provincial stratification of malaria prevalence in the DRC, the population of diseased female *anopheles* mosquitos varies drastically between health zones.

Strata	Parasite prevalence	Main determinant	Provinces	% Population
I.	≤5%	Mountain zone - hypo endemic	Nord Kivu	8%
II.	6-30%	Equatorial and tropical zones - meso endemic	Kwango, Kwilu, Sud Kivu, Mongala, Sud Ubangi, Mai Ndombe, Equateur, Tshuapa, Kongo Central, Tshopo, Haut Katanga, Haut Lomami, Kasaï, Kasaï Orientale, and Sankuru	55%
III.	> 30%	Tropical zone - hyper endemic	Nord Ubangi, Bas Uele, Haut Uele, Ituri, Maniema, Lualaba, Kasai Central, Tanganyika, and Lomami	27%
IV.	8.1%	Urban context, with variations from the city center to the periphery	Kinshasa	10%

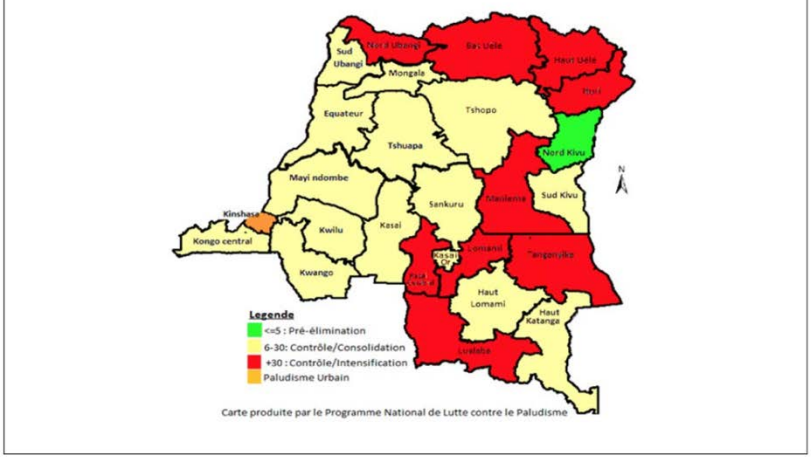

Figure 1. Provincial stratification based on malaria parasite prevalence, DRC-DHS II 2013-14. Reprinted from "U.S. President's Malaria Initiative DRC Malaria Operational Plan," USAID. 2018b

This variance can be explained by the following two factors: altitudinal differences and variations between urban and rural living environments (Ilunga et al., 2014). Mosquitoes primarily do not dwell in areas that have higher altitudes. In fact, in certain mountainous provinces in the DRC, such as North Kivu, residents typically only contract malaria from trips down the mountain where they traverse beneath what is commonly referred to as the mosquito line (USAID, 2014). Additionally, in urban-industrialized areas the population possesses homes sealed off from the environment and will generally spend more time indoors due to electric lighting and an increase in indoor activity. Furthermore, urban environments reduce suitable vector breeding sites for *anopheles* mosquitoes by decreasing standing water through adequate sewage and drainage mechanisms (Donnelly et al., 2005). These factors greatly decrease the likelihood that the Congolese people living in this area will contract malaria. The health-zones marked red in Figure 1 not only reveal the extremely prolific nature of mosquitoes, the zones uncover a cyclical pattern of non-treatment and infection. This pattern is most evident in areas of the DRC where untreated malaria levels remain high the mortality rate of vulnerable populations rises (WHO, 2017).

Figure 2 depicts the village center in Kisangani, the capital of the Tshopo province. Tshopo is located in a mesoendemic, or location where the endemic disease of malaria only affects a moderate portion of the at-risk population, where medium levels of industrialization have been occurring. The urbanization of this community has led to an increase of indoor activities and better sewage and drainage systems; decreasing the breeding zones for mosquitoes and reducing plasmodium pervasiveness.

Figure 2. Village center in Kisangani, the capital of the Tshopo province

Source: RFI. (2016, July 26). RDC: Affrontements entre la police et des taxis-motos à Kisangani. Retrieved April 07, 2018, from http://www.rfi.fr/afrique/20160726-rdc-affrontements-entre-police-taxis-motos-kisangani

Figure 3 illustrates a house located in Kajiba, within the Kasai Central province. This province remains hyperendemic where malaria affects a large percent of the population. This is in many parts due to the rural area surrounding Kajiba, lack of industrialization by ways of sealed-off homes and proper sanitation and water drain-off.

Figure 3. A house located in Kajiba, Kasai Central province

Source: World Food Programme. “WFP's Immediate Response Account - Saving Lives in the Kasai Region of DRC.” *World Food Programme Insight*, World Food Programme Insight, 8 Mar. 2018, insight.wfp.org/wfps-immediate-response-account-saving-lives-in-the-kasai-region-of-drc-b029bdb4e5af.

The bodies of standing water, warm environments conducive to vector breeding, and adequate food supply for the new mosquito population all are factors which contribute to parasite prevalence as referenced by the climate, altitude, and annual precipitation levels (Walker & Lynch, 2007). These factors are referenced below in Table 1.

Table 1. Major malaria vectors and their breeding habitats.

Source: Walker, K., & Lynch, M. (2007). Contributions of Anopheles larval control to malaria suppression in tropical Africa: review of achievements and potential. *Medical and veterinary entomology*, *21*(1), 2-21.

Region of Activity	Vector Species	Main Larval Habitats	References
Afrotropical Region: sub-Saharan Africa	*Anopheles gambiae* Giles s.*l.*,mainly *Anopheles arabiensis.* Patton *Anopheles gambiae* Giles s.*s.*	Temporary sunlit pools without vegetation; wells and ricefields	Gillies & de Meillon (1968); Githeko *et al.* (1996); Robert *et al.* (1998); Gimnig *et al.* (2001)
	Anopheles funestus Giles	Large water bodies with emergent vegetation	Gillies & de Meillon (1968); Gimnig *et al.* (2001)

Places where malaria is already pervasive can be especially detrimental as the Congolese living in these areas oftentimes develop a tolerance to *plasmodium*, choosing to live with malaria symptoms rather than seeking treatment (Mvumbi et al., 2016). The resistance is caused by the fact that the Congolese will contract malaria dozens of times throughout their life, creating the resistance. Deciding not to seek treatment further complicates the cycle of malaria eradication because the *plasmodium* is transferred from person to person via the mosquito; the more pervasive *plasmodium* is within a population, the easier it is to spread malaria. Additionally, the *plasmodium* tolerance perpetuates the normalcy of malaria and as a result fewer Congolese seek treatment, resulting in higher levels of exposure and mortality in vulnerable populations.

The current government-run health system that exists in the DRC consists of three main levels: the central level, the intermediate level, and the national level. This structure exists to assist the dissemination of aid and access to medical care throughout the country. Fourteen Centrales de Distribution Régionales (CDRs) currently exist and the government is currently pursuing efforts to add additional CDRs so that each province contains one CDR (USAID,

2018b). This addition is necessitated by the recent expansion from 11 to 26 individual health zones, allowing the decentralized model to better serve the Congolese people in the health and medical aid supply chain (USAID, 2014). Over 8,000 public, and nearly as many private, health facilities exist, and nearly as many private. Very little information is known regarding the geocodes for the CDRs and health facilities. The various levels and components of the DRC health structure are illustrated below in Figure 4.

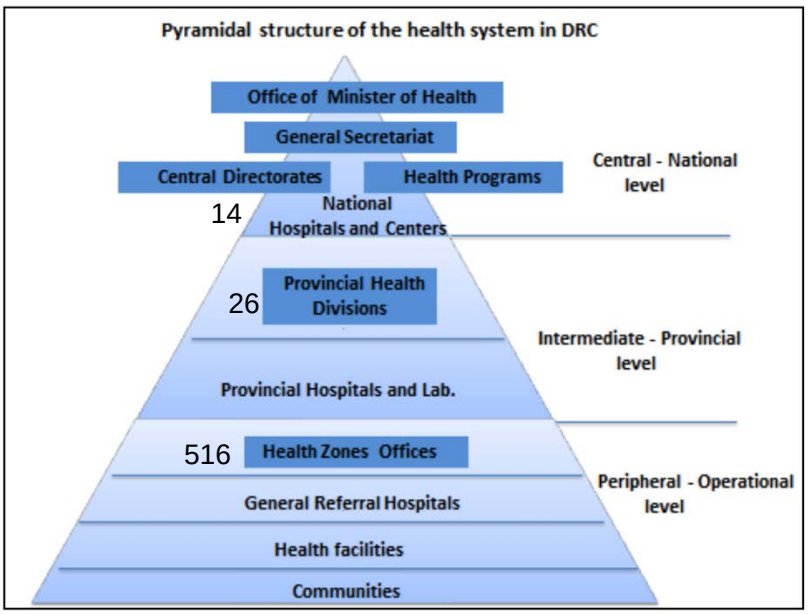

Figure 4. Structure of the health system in the Democratic Republic of the Congo.

- "The central level, which includes the Minister of Health, the Secretary General, Central Directorates, disease-specific programs such as HIV/AIDS, tuberculosis, and malaria, as well as national hospitals and reference centers;
- The intermediate level, composed of 26 provincial health divisions (Division Provinciale de la Santé, DPS), 26 provincial health inspection offices, provincial level hospitals and laboratories, and regional drug distribution warehouses Centrales de Distribution Régionales (CDR), located at intermediate level. The disaggregation from the previous 11 to current 26 provinces is still a work in progress at this point,

and some structures, including the National Malaria Control Program do not yet have offices and representatives at all the new provincial capitals;

- The peripheral level comprised of 516 health zones, general referral hospitals, 8,504 health areas, 8,266 of which have a government health center (health facility) where clinical services are provided (approximately 15-20 health centers per health zone)" (USAID, 2017).

Source: "U.S. President's Malaria Initiative DRC Malaria Operational Plan," USAID. 2014

The health management information systems (HMIS) focuses on data collection and systems in the DRC. Most of the countries in sub-Saharan Africa have adopted and use the DHIS2 platform (the existing health information system), including DRC. In DRC, this has been a three year scale up process, implementing hardware and training people on how to input the data, and garnering agreement on which data elements across all health elements can be included so as to not overburden the health staff responsible for submitting these data. The process has faced many challenges, and one major one is stable Internet connection across the 516 health zones (districts) in DRC. About 20% of zones do not have adequate cell phone reception, which means even with a USB modem, they can't transmit the data. The notion of ensuring regular access to internet or even cell phone reception across the country, particularly in the remote areas where commodities are often most needed, is a major challenge. Additionally, many aspects of this technology require technicians, of which there are only a few that are based in Kinshasa, to constantly run around the country resolving often minor issues (Anonymous, personal communication, 2017).

Furthermore, The National Essential Medicine Supply Program is responsible for implementing the National Essential Medicine Supply system that consists of a centralized pharmaceutical procurement system through a nonprofit association (Fédération des Centrales d'Achat des Médicaments Essentiels), which is not yet fully functional, combined with a decentralized warehousing and distribution system through 14 CDRs (SIAPS, SCMS, IHP, and USAID, 2014). This highly complicated supply chain structure can be viewed in Figure 5 below. This Figure details the numerous concurrently existing supply chains in the DRC, including separate supply chains for various commodities and separated by sources of financing, procurement, storage locations, and points of disseminating the aid to the patient. This process creates a complex issue in reference to malaria aid as this process increases costs, drastically reduces efficiencies, and ultimately harms both effective logistics efforts and efficiencies.

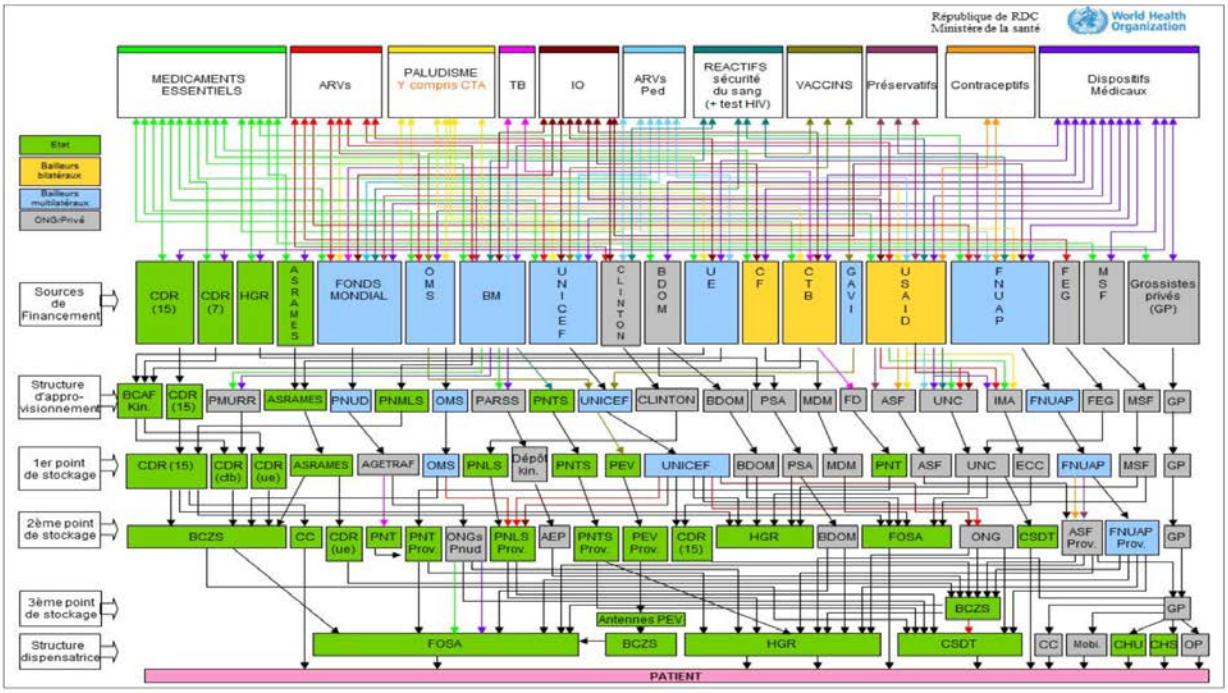

Figure 5. Pharmaceutical products supply chain in DRC, 2009.

Reprinted from: "Cartographie des Systèmes d'Approvisionnement et de Distribution des Médicaments et Autres Produits de Santé en RDC," WHO/PNAM. 2009.

A communication and information gap exists between the current malaria aid supply chain, which is both weak and nonexistent in many areas of the DRC, and an effective decentralized model that takes into account a more thorough view of the factors inhibiting supply chain effectiveness and efficiency (Village Reach, 2015). Currently a substantial amount of research exists on the various factors inhibiting the malaria supply chain in the DRC. However, oftentimes research documents do not address all known factors inhibiting malaria aid and rarely has analysis been conducted on the complicated cyclical events that manifest themselves into the complicated supply chain environment in the DRC, specifically in reference to all malaria-related mortality in the DRC. Consequently, humanitarian aid efforts in the DRC mainly focus on the major antimalarial commodities such as residual spraying, artemisinin combination therapies (ACTs), rapid diagnostic tests (RDTs), and insecticide-treated nets while rarely considering the entire scope of existing research due to the time involved to aggregate all factors inhibiting effective malaria aid. This research seeks to bridge this gap and improve the current approach by creating a detailed list of factors inhibiting the current success of cost effective long-term malaria in the Congo. After analyzing all of the factors inhibiting malaria aid in the DRC, the elements were compiled into six categories of issues.

The research will contain a two-pronged approach and will focus on both the prevention and treatment of malaria. Furthermore, it will investigate both the internal (from within the DRC) and external factors (Out-of-country factors) affecting the malaria aid supply chain in reference to six categories of DRC-centric issues: infrastructural aspects, financial aspects, health structure aspects, organizational aspects, political aspects, and socio-economic aspects.

Underneath the categorical lens noted above, this document focuses on the distribution of malaria aid, not the production or development of humanitarian malaria aid. This includes the

socioeconomic and cultural challenges of aid access and aid usage. Historically, providing aid availability in the DRC has been the main challenge, but due to supply chain improvements current stock out rates have since improved (Mpanya, Tshefu, & Likwela, 2017). Stock out risk still remains and has since migrated from a vaccine distribution supply chain issue towards the six systemic issues (Mikkelsen-Lopez, Shango, Barrington, Ziegler, & Smith, 2014). No matter how effective or ineffective the distribution of aid has become, if it is not utilized as intended it will do nothing to improve the current conditions. The modern supply chain management approach to the elimination of Malaria in the DRC focuses on the symptoms – such as poverty and an increase in illness severity – created by a malaria-laden country. This study endeavors to identify the causal factors impacting malaria mortality in order to provide a more holistic view of humanitarian aid.

This multidisciplinary method shifts the argument towards investigating these issues as a product of culture; supply chain has the unique ability to solve these problems by focusing on the timely cost-effective transportation of the necessary products while considering the inner-network of the nation and cultural idiosyncrasies. The aim of this research is to streamline humanitarian aid by eliminating the iterant data accumulation processes of consulting numerous data sources and replicating existing research in order to factor in most known variables to determine a more holistic view of supply chain improvement in the DRC. This study employs a literature review and a semantic analysis to ascertain both an academic and on-the-ground perspective of the malaria situation as it currently exists in the DRC. The semantic analysis is limited to a series of ten interviews and was used to validate the information gathered in the literature review.

CHAPTER II

LITERATURE REVIEW

This literature review section presents an accumulation of past literature following an adapted categorical methodology, it will then discuss the findings and demonstrate the inner relation between DRC-centric issues. While existing research partially answers the question, "What current challenges adversely affect, or increase the cost of, effective malaria prevention and treatment within the Democratic Republic of the Congo?", each article focuses on a different factor or aspect of the issue. Six categories of issues were created based on the 408 challenges documented in the study *Challenges to the Successful Implementation of e-Government Initiatives in Sub-Saharan Africa* and encompass the six major categories of issues within Sub-Saharan Africa (Nkohkwo & Islam, 2013). After this literature review analyzed the most pervasive issues within the DRC, the researchers noted that the existing issues closely mirrored the results of the aforementioned study. Meaning, the many of the governmental challenges evident throughout Sub-Saharan Africa are present in the DRC. The research team applied the categorical model noted in the research document "Challenges to Successful Implementation of e-Government Initiatives in Sub-Saharan Africa" and applied it to all issues inhibiting malaria aid in the DRC. Furthermore, the team included an additional category "health structure aspects" and excluded the "human aspects" category. This root cause analysis better encompassed the issues inhibiting malaria aid in the DRC by narrowing the focus from e-initiatives in Africa to malaria-related issues specifically in the DRC. Therefore, the researchers decided to utilize the framework of the six overarching categorical challenges as the backbone to this research. Below the researchers defined each category as it is referenced within this study:

Table 2. Definitions of categories effecting supply chain management in the DRC.

Source: "Challenges to the Successful Implementation of e-Government Initiatives in Sub-Saharan Africa: A Literature Review," by Nkohkwo, Q. N. A., & Islam, M. S., 2007, *Electronic Journal of e-Government*, 11, p. 1.

Infrastructural Aspects	ICT infrastructure, security, privacy, information sharing, interoperability, data possession, explicit reference to ICT access, power supply, Internet access and connectivity, scarcity of computers, digital divide, cyber security, collaborating systems, maintenance of government websites, tele-density, data systems
Financial Aspects	Financial constraints, cost structure, Internet cost, and cost of e-government services.
Health Structure Aspects	Awareness, human resources, attitude, learning content/resources, accessibility, trust, public support, knowledgeable personnel, gender in- equality, low citizen participation, training and capacity building, E-record readiness
Organizational Aspects	Top management support, leadership, deficiency and implementation guidelines, recruitment of ICT personnel, change management, human capital development, lifelong learning, organizational motivation, information management, internal efficiency, non- contextualization of e-government practices, partnership between private and public sector, ability and commitment, disintegrated projects, e-government vision, evaluation framework, transparency, citizen inclusion.
Political Aspects	Political situation**,** leadership**,** political administrative system, public administration reforms, legal framework, ICT roadmap, fiscal policy resources, procurement regulation, e- government policy execution, freedom of press, political will, data privacy legislation, e-government strategy, regulatory issues, data standards, national policy on the use of ICT
Socio-Economic Aspects	Illiteracy, economic development, culture, demography, digital culture, poverty, corruption, competition environment, language barriers, permanent availability preservation/sustainability, appreciation of perceived IT value, benchmarking, communication, unemployment rate, E-literacy, accessibility

Additionally, the data contained within the aforementioned research located in Table 2 in reference to the various challenges to providing malaria aid (e.g., political instability, economic instability, insufficient funding, communication lag, aid organization interconnectivity issues, etc.) and information sources regarding inhibitive factors to malaria remain scattered (Pan African Medical Journal, 2016). At this time, no one has compiled the data into a single comprehensive document. As such, researchers and supply chain experts must replicate existing research or consult numerous data sources in order to factor most known variables into their antimalarial strategy. This repetitive and time-consuming process hinders research progress and subsequently streamlined humanitarian aid. The literature review utilized peer-reviewed publications created by entities conducting or funding work in the DRC in addition to existing research and doctoral theses. This study used peer-reviewed studies and works by reputable institutions to ensure the validity of the data included in this study but not independently verified by this research team. Documents published prior to 2005 were excluded from this study, as in-country conditions in the DRC have transformed over time.

In order to provide a more comprehensive literature review, the following three types of literature were used: historical sources, peer-reviewed articles, and governmental or NGO reports. These three types of sources collectively provided insight into the DRC's supply chain from a holistic, anthropological, and cultural perspective. The Google Scholar web search engine and research databases were used to locate relevant documents that adhered to the parameters of "malaria" and "DRC." This study focuses on the four basic malaria prevention and treatment efforts, including: artemisinin combination therapies (ACTs), insecticide-treated bed nets, rapid diagnostic tests (RDTs), and residual spraying. This approach focuses on the creation of an accumulated analysis encompassing external and internal issues juxtaposed with preventative

and treatment measures and investigates six categorical issues known to undermine humanitarian aid efforts: infrastructural aspects, financial aspects, health structure aspects, organizational aspects, political aspects, and socio-economic aspects.

Infrastructural Aspects

Despite the DRC containing approximately 25 trillion dollars in natural resources, it remains one of the most difficult countries to operate in geographically due to the lack of infrastructure and the high cost of transit (Human Rights Watch, 2017). Because of this, medical facilities experience extreme difficulty acquiring and transporting malaria commodities, resulting in high stock-out risk on the operational level (Guyant et al., 2015). The lack of roads, electricity, cell reception, adequate medical facilities, and infrastructure all contribute to the lack of industrialization in the DRC (Canada: Immigration and Refugee Board of Canada., 2012). This lack of industrialization gives way to the optimal breeding grounds for the *anopheles* mosquitoes and without electricity and indoor activities in an environment sealed off from the elements it provides ample opportunity for *plasmodium* transmission (Swana et al., 2016). Internally, the majority of roads remain in a state of disrepair and are oftentimes washed out. This dearth of roads causes difficulty when transporting antimalarial commodities through the country (PricewaterhouseCoopers, 2018). Additionally, when a road is washed out it is a common practice in the DRC for one individual to repair the road and then sit by that section of the road and force travelers to reimburse him for the cost of time, labor, and materials it took to fix the road. This act is not seen in any form as corruption, rather it is seen as a means of payment for services rendered. Furthermore, when preventative commodities and medication for malaria treatment cannot be readily transported it may cause antimalarial commodity stock out. For this reason, many supply chains in the DRC utilize multimodal transit. Multimodal transit not only

increases the costs, but it also forces the transportation of goods in lower qualities when transit necessitates the use of motorcycle travel or travel via canoe (Adeya, Bukasa, & Tomsej, 2009). The physical road infrastructure is further complicated by the current approach to information systems management in the DRC (USAID, 2014). The lack of internet, cell phone reception, and electricity in many parts of the country creates difficulty in predicting and relaying stock out issues and inventory on hand levels. Communication transmission is a huge issue that could be fixed by increasing and investing in better infrastructure in the DRC. Luckily, the way aid is currently disseminated is changing as NGOs are currently working on developing a better information system management that will assist with some of the stock out and inventory level issues (USAID, 2014). However, the multiple aid organizations collaborating on this project to improve the physical and information infrastructure system must operate under significant funding and capital constraints. Some researchers suggest that to minimize the cost of transit in the DRC, the commodities should be shipped by the cost of weight, not by volume. The provinces located on the east side of the country are incredibly difficult to access because driving across the country is rarely a viable option. However, travel via vehicle is far less expensive then renting a plain to transport the commodities, further limiting viable transit options.

Financial Aspects

Due to political and economic instability, coupled with a lack of internal funding, the country relies almost wholly on outside funding from Global Fund, the President's Malaria Initiative (PMI), and the Department for International Development (DFID). International funding for malaria aid has quadrupled since 2007, allowing for increased preventative and treatment investment; however, the two billion dollars of donations annually is far shy of the necessary five billion dollars to provide universal access to basic malaria interventions (WHO,

2017). In fact, this increase of funding has directly contributed to the DRC's ability to decrease the current instance of malaria down to less than 25% (WHO, 2018). Although this funding has historically increased, donation growth has slowed over recent years and remains at risk of a plateau. This is significant because historically foreign entities have had to act as the catalyst for change by pushing countries towards the realization that their view of normalcy can be improved (Roser & Hannah, 2015). Given the plateau researchers and NGOs must learn how to maximize the spending power of that money. To continue this upward trend of eliminating malaria and decreasing the current instance of malaria in the DRC, aid must migrate from a platform of simply providing to stimulating in-country aid efforts and instead spearhead economic independence. The DRC currently remains almost entirely reliant on external funding for antimalarial commodities, drugs, and improvement projects. The country does not have the capital to fund necessary malaria aid. These foreign entities can place restrictions on the money and earmark it for a predetermined set of initiatives that may not align culturally with the DRC. Funding sources for malaria initiatives is illustrated in Figure 6; funding for malaria aid is almost entirely derived from sources outside the DRC government.

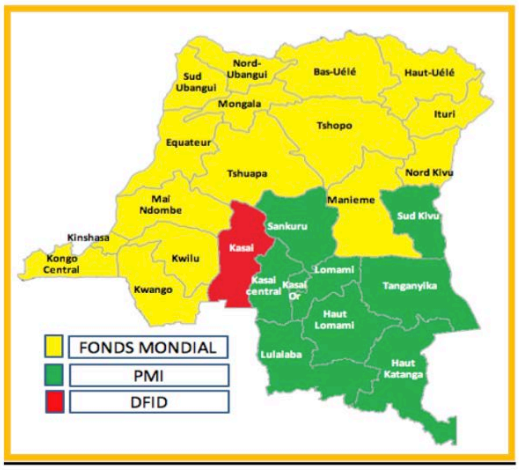

Figure 6. 2018 DRC malaria donor map.

Reprinted from: "U.S. Malaria Operational Plan FY 2018," USAID. 2018b.

Malaria commodities (medication, tests, and preventative measures) remain highly subsidized in the DRC in the hope that lower costs will increase the ability of the Congolese people to readily access the treatments (USAID, 2018b). Researchers believed that this would migrate the issue from usage to stock out, forecasting, and antimalarial commodity availability. Rampant poverty has led to this being a huge issue as they cannot get enough money to purchase the medication when they need it, regardless of the heavy subsidy. Despite the fact that the DRC remains one of the most poverty-stricken countries in the world, rating 176 out of 187 on the Human Development Index, the country's GDP has grown significantly from 2013 where it grew by 8.5 percent (World Bank, 2017). "Growth in 2014 was measured at 9.5 percent. Prudent monetary policies have not only encouraged this growth, but have kept inflation at one percent, the lowest inflation rate exhibited since the nation's independence over half a century ago" (Trustfall, 2015). Historically, less than 6% of citizens in the DRC knew about property taxes and less than 1% paid the tax. Recently, door-to-door tax collection has begun and despite few believing tax collection would cause the poor to become even poorer, it drastically increased the number of individuals paying taxes voluntarily and participation in the political process by 28% (Weigel, 2017). This program was successful because when individuals contribute financially to their government they wish to ensure efficient and non-corrupt leadership that operates with the best interest of the people at heart.

Health Structure Aspects

With almost no access to cell phones, the internet, or even electricity, the DRC employs a decentralized healthcare system to better manage efficient and effective aid delivery. However, a significant communication lag exists between district and provincial health care levels (DRC). Supply chain security remains an issue concerning counterfeit antimalarial drugs and theft

(Newton, Green, & Fernández, 2010). The lack of interconnectivity between aid organizations has led to a massive duplication of effort leading to over 40 independent vertical supply chains existing in the DRC (Adeya, Bukasa, & Tomsej, 2009). Finally, the lack of adequate human resources is a complicated issue mainly due to two factors: the lack of leadership and the lack of effective management. Of those who are willing to do the work, few possess the skills to work on the malaria supply chain. Medical facilities experience very high turnover, and they frequently do not have time or resources to train the staff (USAID, 2017). However, if the staff was better-trained those skills would enable them to find a higher-paying job, necessitating incentives to stay.

The health structure struggles with corruption at every level and struggles with the introduction of counterfeit medication and a lack of integration between levels of the health structure. This lack of interconnectivity can be partly attributed to the lack of information technology systems and the current level of complexity that lies within the current method of distribution. Furthermore, dozens of supply chains operate concurrently, increasing the cost of providing medical aid.

Multiple treatments exist for malaria, depending on the severity of infection; however, because of the variety of treatments it is more difficult to ensure that stock of all of the below commodities remain available. Doctors will recommend an artemisinin-based combination for simple malaria including one of the following two treatments: 1. Artesunate + Amodiaquine (AS-AQ) 2. Artemether + Lumefantrine (AL). For the treatment of severe malaria doctors recommend one of the following two treatments: 1. Artesunate injectable then relay with (AS-AQ or AL) 2. Quinine and relay with quinine combined with clindamycin hydrochloride. For prevention, pregnant women utilize Sulfadoxine-pyrimethamine (SP) or Fansidar) and

chemoprophylaxis during a prenatal consultation. These monotherapies and combination therapies are always prescribed alongside the use of insecticide-treated mosquito nets for prevention, ACTs, and quinine combined with sulfonamides. Beginning two years ago, health clinics began giving Fansidar to infant children to ease the malaria-related mortality rate. Natural treatments also exist to ease the malaria burden in remote regions of the DRC.

Organizational Aspects

In regard to the current organization and management of the health system, especially within nonprofit clinics and other aid-supported medical facilities, organization can be incredibly difficult due to communication lag. Additionally, individuals, often medical professionals, managing the supply chain have no training and do not know how to collect or utilize data (Molla, 2016). This lack of interconnectivity between levels of the health structure is severely lacking and leads to stock out issues and a lack of historical use data. When nonprofit organizations and different levels of the health structure fail to communicate with each other it creates a costly and unnecessarily complex supply chain process (Lorenson & Mvundura, 2013). Very few individuals possess a management information system or logistics background in the DRC. People on-the-ground working with disease-centric aid or nongovernmental efforts simply do not have time for the clerical work necessary to streamline operations. Additionally, if provided with data to better run health clinic operations many of the doctors and nurses would not have the time nor skills to translate that data into usable information to aid patients.

Because foreign entities fund a vast majority of malaria-related aid efforts in the DRC, they also assist in developing the overall strategy of malaria aid. However, the aid organization focus more on providing the aid to those that need it instead of focusing on providing sustainable long-term aid that the Congolese people can produce in-country (USAID, 2017). As mentioned

in the financial aspects section, the current funding resource pie is nearing a plateau. In the case that the pie cannot be expanded, current aid efforts must learn to operate more effectivity while utilizing fewer resources. Migrating to a platform where instead of handing out the commodities for free, they ask the Congolese people to pay a menial fee or perform a job to earn or purchase the commodity. This would essentially reattach a value to it and possibly increase usage and adoption.

Corruption permeates every level of the health structure. While corruption has declined over the last 15 years, it still remains a significant issue. Oftentimes when a health center is promised a certain sum of money they will order as much medication and aid supplies as the grant allowed. This becomes an issue when one considered the rampant corruption; money is often scooped off the top of the grant as the money passes through each level. Ultimately, this reduces the amount of money that the health professionals have to spend on aid and harms the Congolese people.

Political Aspects

War and violence begets the Congolese government's ability to effectively manage the DRC. The DRC has a violent and tumultuous history encompassing 80 years of colonization, 50 years of dictatorship, and more than 20 years of conflict (Council on Foreign Relations, 2018). This complex history has led to an unstable political system. The dozens of armed militia groups claiming to fight for one cause or another ultimately results in a confusing string of violence that gives rise to a select powerful few and further exacerbates the efforts that many believe would give way to progress (Rosen, 2013). The current political state of the country significantly impacts humanitarian aid efforts as corruption, bribery, and theft inhibit the dissemination of intact aid to the peripheral and intermediate levels of the health structure. The political system is

stuck in a seemingly endless cycle in which war and violence begets the government's lack of capacity to deal with such matters. The government is operated in such a way that the current ruling party is focused more on maintaining their own power than the restoration of the country at large (Clowes, 2017). In fact, while conducting interviews the current political situation between the Congolese people and ruling political party escalated as current leadership again attempted to maintain power, resulting in violence and an internet shut down that hampered the research team's ability to communicate with sources currently residing in the DRC (International Crisis Group, 2017).

Socio-Economic Aspects

The study *Malaria and Poverty* published in the *New York Academy of Science* journal has demonstrated the causal connection between poverty and malaria (Teklehaimanot & Mejia, 2008). It is widely known that poverty and disease have a magnified detrimental effect in locations where malaria exists than when the same location no longer has malaria (Owens, 2015). Due to the plethora of complicated logistic, geographic, and economic challenges in the Democratic Republic of the Congo, including poor inventory management, insufficient human resources, lack of infrastructure, communication lag, and duplication of warehousing efforts, it has the third highest rates of malaria pervasiveness per capita in the world (USAID, 2018). By the time the average Congolese reaches adulthood they have contracted malaria so many times that they have developed a relative immunity to the *plasmodium*. This drastically reduces their willingness to take preventative and treatment medication and use antimalarial commodities such as insecticide-treated mosquito nets (Mwenesi, 2005). These nets often block the cool night breeze and leave the people inside hot, causing discomfort to those sleeping under the net. The governmental entities and people living in the DRC truly don't see malaria as an issue; they see

living with malaria as simply a reality of life. Furthermore, they expect to be receive preventative and treatment commodities for free further complicating the cycle. The mentality that antimalarial commodities will continue to be handed out for free creates a systematic reliance that detaches value from the commodity. For example: because NGOs provide mosquito nets. They do not want citizens to turn around and sell the nets; therefore, the government has made it illegal to sell treated bed nets. Not only does this not allow people to buy them when needed, it does not allow for in-country production. This cyclical process reduces the ability of the Congo to become self-sufficient. This cycle also cripples any opportunity that the country has to begin transitioning to a mode of commodity dispersion in which value remains attached to the commodity though alternative methods of payment, work opportunities, and the construction of commodity production facilities within the Congo.

Without the aid of an overarching political strategy the parties in power act in their own self-interest that often undermines their own long-term role in the unstable political process and forces the Congolese people to rely on foreign aid. Although substantive governmental progress has been made over the years, the DRC still relies almost entirely on foreign aid to combat malaria-related issues. Funding for malaria aid can be earmarked for specific causes that do not necessarily adhere to cultural requirements. For example, many people historically used, and some continue to use, mosquito nets as fishing nets because targeted education and training was unavailable and the nets over a very convenient method to catch fish. The Congolese people have more of a short-term perspective, focusing on their current well-being, rather than a long-term orientation where they focus on bettering their condition over the long term. This mentality exacerbates poverty and is common among the current population. This mentality exacerbates the current in-country issues as those who have developed a resistance to *plasmodium* do not

seek treatment and instead decide to live with malaria, expediting malaria transmission (Gelband, Panosian, & Arrow, 2014).

CHAPTER III

METHOD

Research Methodologies

Employing a qualitative knowledge-based interview followed by a semantic analysis, this document includes primary sources in order to present a more comprehensive summary of the issues affecting malaria prevention and treatment in the DRC. The purpose of this methodology is to identify the supply chain issues affecting malaria commodities as well as other challenges impacting and contributing to malaria mortality rates (Doumbia, Clark, & Mwansasu, 2017). This methodology was selected due to location, time, and budget constraints, focusing instead on garnering multiple perspectives from across key areas of the Congo in an effort to corroborate the aforementioned research. The researchers involved received intensive human subjects research (HSR) and Collaborative Institutional Training Initiative (CITI) training and the study received approval from the Texas A&M Institutional Review Board (ID # IRB2017-0888M).

Research Participants

Approximately 40 individuals possessing practical knowledge pertaining to malaria aid in the DRC were contacted and 10 contacts were interviewed. The subjects were identified first by occupational involvement in the DRC, number and duration of country visits, and academic understanding of DRC issues. The research participants selected were required to have either lived in the DRC for at least two years or have worked in the country for two years and possess knowledge of malaria and the health structure of the country. Potential interview participants included medical aid workers, doctors, health-center workers, non-governmental organization (NGO) employees, medical aid organization staff, and DRC residents. These individuals were

selected in order to provide a broad perspective on the issues inhibiting effective and efficient malaria aid that focuses on both prevention and treatment. While the sample size was limited to 10 interviewees, the purpose of the semantic analysis was to verify the findings of the literature review. Additionally, the study accounted for the drastic variability of malaria and accessibility to aid between provinces through mapping of interviewee location and referencing both altitudinal and locational data. To gain a more comprehensive view of the current state of medical aid in the DRC, the research team included individuals with practical experience from the following areas of the DRC: Kinshasa, Maniema, Kasai, Tshuapa, Equateur, Haut Katanga, and North Kivu. The provincial locations of the interviewees are outlined in red below in Figure 7.

Figure 7. Interviewee location based on DRC provincial stratification.

Qualitative knowledge-based interview

The researchers in this study sought to identify factors contributing to ineffective and inefficient malaria aid in the Democratic Republic of the Congo and to gather a current on-the

ground perspective of daily life in the DRC. The factors that create the main issues related to malaria were extracted from the interview in order to provide a comprehensive reference point for future researchers and humanitarians interested in the Congolese malaria crisis. This qualitative knowledge-based interview was utilized to determine an on-the-ground view of primary impacts on malaria aid and the contributing subcomponents of each significant facet impacting the antimalarial supply chain. Knowledge-based interviews are a qualitative research methodology that allow the collection of unfiltered data by asking the interviewees a series of open-ended questions. These questions are meant to point the individual to a general topic and allow them to divulge what they know and understand about the topic at hand, ultimately resulting in minimal researcher bias. The resulting data from these interviews were ultimately transcribed and utilized in the aforementioned semantic analysis to derive insights on malaria-centric issues in the DRC.

Interview Questions

A series of interview questions were developed (See Appendix A and Appendix B) in an effort to identify the key issues inhibiting effective malaria aid in the DRC. The intent behind the first question was to ensure that the interviewee was qualified to speak on the topic of malaria aid in the DRC and to eliminate those who were not qualified. Questions two and three determined if the interviewee truly possessed practical knowledge on the current state of malaria. These responses were verified against current statistical data and information on malaria mortality rates and common prevention and treatment practices. The next eight questions were designed to gauge the interviewee's opinion on the current antimalarial supply chain processes and their perceived effectiveness. Furthermore, these inquiries were utilized to gain a better understanding of the current state of transportation methods, roads, commodity availability, and

the issues contributing to these supply chain-centric challenges. Questions twelve through nineteen investigated the availability and effectiveness of current prevention and treatment efforts from a sociological and cultural perspective. To ensure that all relevant information was gathered, and the interview was comprehensive, the researchers included question twenty as a free-response question. All research questions were critically examined by the research team and subsequently included in the Texas A&M Institutional Review Board application, and later approved.

Interview process

The research population was contacted via email and asked to participate in a research study on the usage of antimalarial commodities and the supply chain mechanisms underlying the systemic issues that exacerbate malaria-related mortality. Additionally, the participants were asked to refer other potential interviewees and provide contact information of those with practical knowledge of DRC-centric issues. After initial contact with an interviewee, the informed consent document, information sheet, and interview questions were sent in English via email or messenger application. If the interviewee's main language was French, a list of interview questions was provided in their native language and the received written answers were translated using Google's translation feature. The interviewee then confirmed receipt of the aforementioned documentation prior to the start of the phone interview. They then gave consent to participate in an interview with the option of consenting to audio or video recordings to be made during their participation in this research study. Given the size of the study, no potential participants were declined an interview.

Semantic analysis

The researchers employed a semantic analysis using the transcribed data (both in English and French) from the qualitative knowledge-based interviews below. The analysis identified key phrases, sentences, and ideas within the text and identified main themes and the subcomponents of each, noted in the below semantic analysis. The results of the survey will be used to determine an on-the-ground view of primary impacts on malaria aid and the contributing subcomponents of each significant impact. The researcher endeavored to articulate the main issues inhibiting efficient and effective malaria aid in the Democratic Republic of the Congo. The researchers extracted the factors creating the main issues in order to provide a comprehensive reference point for future researchers and humanitarians interested in the Congolese malaria crisis. Emergent themes were categorized in each of the three categories of DRC-centric issues: scientific aspects, cultural aspects, and economic aspects.

CHAPTER IV

RESULTS

Characteristics of Research Participants

The sample size of the aforementioned qualitative knowledge-based interview and subsequent semantic analysis consisted of 10 individuals who represented a broad spectrum of perspective and opinions on malaria aid in the DRC. Four major groups existed in the study, as demonstrated in Table 3 below, which included doctors and health workers, government employees, aid workers, and students. The average participant's educational background consisted of a doctorate degree with more than 10 years of experience with malaria-related issues in the DRC. Furthermore, 25% of the population resided in countries outside of the DRC but had lived in the DRC for a time ranging from 2 to 20 years.

Table 3. Interviewee categorization and breakdown of characteristics.

Interview Subjects	Subject Characteristics	Subject Employment	Years of Malaria or DRC Involvement	Location
Subject 1	Tanzania Malaria Researcher	PhD Student	2	–
Subject 2	Aid Worker	Senior manager of a health systems group	7	Urban / Rural
Subject 3	Lived in the DRC for 10 years treating people from (1989 – 2011). Started a clinic that later became a district hospital	Physician Assistant	22	Rural
Subject 4	Conducted site visits to NGOs in the DRC.	Program Coordinator	2	Urban
Subject 5	Works in conjunction with a research institute	Engineer	5	Urban / Rural
Subject 6	Works with a School of Public Health	Professor	3	Urban

Table 3. Cont. Interviewee categorization and breakdown of characteristics.

Subject 7	Works with malaria treatment, therapeutic protocols, and actors in the quality of care approach	Congolese Nurse	18	Urban / Rural
Subject 8	A doctor and former Chief Medical Officer for an immunization program	Medical Director of a Reference Health Center	15	Urban / Rural
Subject 9	–	Medical Aid Worker	16	Urban / Rural
Subject 10	Works in an occupation allowing access to the lower and mid-levels of the health structure	Community Leader	20	Urban / Rural

Research Findings

The participants overwhelmingly stated that malaria was an endemic disease that was among the top five causes for morbidity and mortality in most provinces in the DRC. Subject 6 said. “it accounts for over a third of all the deaths in the Congo and while I don’t know the specific numbers, but it has accounted for about half or more of all the infant mortality.” This mortality has severe repercussions. Much of this is because the climate and elevation in the DRC allows for the population of the female *anopheles* mosquito to reproduce at a rapid rate and transmit *plasmodium falciparum.* All of the participants agreed that transmission of malaria is impacting a majority of the population because everyone is exposed; however, the rate of adult mortality remains much lower than the infant population (Coghlan et al., 2009). Subject 3 stated, “they do get it, though not as often, though children seem to have less immunity. If they're not able to get good care soon, we do see kids even that come into our hospital maybe from outlying areas come in late and it does impact families by the sickness and then that it is still a big killer.” By the time a person in the DRC reaches adulthood, they have contracted malaria enough times

to have developed a relative resistance to the *plasmodium*, even though “most of the native folks don’t take regular malaria prophylaxis. They don’t have access to it and it’s expensive”, as Subject 6 said. This oftentimes leads victims to not seek medical care, increasing the likelihood that neighboring children will contract the disease. Moreover, “most people didn't live within access of effective malarial cures or treatments. A lot of times the government health centers usually didn't have much medicine. It would often get sold out of the side and when it would first arrive, and so medicine was not readily available” (Subject 3). For a variety of reasons, once contracted it may take a substantial period of time to bring the child to a hospital or clinic for medication, ultimately resulting in their untimely death. The health structure in the DRC continues to be fractured due to the lack of knowledge of health practices and monetary resources of the Congolese people, all of which derive from the poor socioeconomic circumstances experienced by the majority of the Congolese. Some of the impoverished in the DRC have been displaced from their homes due to the widespread violence from individuals or militant groups, which increases distrust in the government; the more people displaced from their homes, the less resources they have to help better their quality of life.

While this study focuses on the most recent 15 years of malaria prevention and treatment methods and their effectiveness at combating malaria mortality in the DRC, during the interviews the researchers also collected a historical perspective encompassing the last 20 years. The way the DRC has historically combated malaria has drastically changed over the last decade, moving from monotherapies, bed nets, and blood smears to the more modern approach of artemisinin combination therapies (ACT), rapid diagnostic tests (RDT), and long-lasting insecticide treated nets. Furthermore, the challenges in the DRC have migrated from drug availability and malaria screening effectiveness to a systemic issue that permeates each level of

their health structure (Griffin et al., 2010). Twenty years ago, not enough was being done to combat malaria in the DRC due to a lack of education, in addition to the five major issue categories (see Table 1). In fact, at the time mosquito nets were the main preventative method and yet many Congolese did not see the value of mosquito nets, instead, as Subject 3 said, "they didn't see the value of the mosquito nets. They would use them for fishing nets, they would sell them, not all of them actually were used for the kids." While the situation today has drastically improved, multiple indicators suggest that the current condition remains less than optimal; Subject 6 described, "the level of malaria, it's just so endemic. It's just that nothing is working well when 1/3 of the mortality in the country is due to malaria. And it's not just anti-malarial, people repurpose those nets into things they feel are more important for survival." Subject 4 described transportation difficulties, lack of infrastructure, poor inventory management, communication lags, and funding issues. The issues mentioned included infrastructure, transportation, communication, inventory management, storage, funding, interconnectivity, and management difficulties that coincide political and economic instability (Nkohkwo & Islam, 2013). The main difficulties health professionals experience, from a supply chain perspective, include regular supply deliveries of the same quantity and quality, improved security to facilitate the deployment of inputs to distant health centers, inventory stock-out predictability, and data analytics. As Subject 3 described, "even when the medicine would get to the hospital, most of the time a good portion of the medicine would not be distributed to the health center like it was supposed to. It would go into a private pharmacy of the chief medical officer and he would just sell out at higher prices." Additionally, Subject 9 stated that "to better fight malaria in the DRC, you must sensitize the population on the scale and the harmful consequences of the disease, the various measures of fight against the malaria and its appropriation by the whole population." The

populations must also be educated on the various measures, and their appropriate usage, existing to fight against malaria; the "people probably need to be continually educated on their benefit so they don't take them and catch fish with them. Sometimes people they don't necessarily see the value of them. Education will at least make the effort more efficient where people see the value and use something like a mosquito net for its intended purpose" (Subject 3). Furthermore, NGOs should make free control inputs available in health facilities and community care sites, including RDT, anti-malarial drugs, and mosquito nets. The care providers must be incentivized through wages and premiums and the Congolese people must ensure that the areas around their households are not conducive to the breeding of mosquitos. The issues mentioned by each interview subject are the symptoms of greater systemic causes in the DRC.

Corruption, geographic inaccessibility, infrastructure, finances, high cost of malaria-related care, and resistance to *plasmodium* remain a small portion of the main issue categories interviewees identified as existing in the DRC. Money is skimmed off the top of the NGO donations at every level of the health structure, impeding antimalarial deliveries and the fulfillment of orders. Donations "from the capital, such as medicine, are transported to the provincial level, then it is distributed to the district level (health districts in the province). Medicine etc. is skimmed off at each level (capital, provincial, and district)" (Subject 3). This rampant infrastructural and political depravity emanates from the lack of morality in the government, trickling down as each subsequent level removes vital funds from their intended destination. These political and medical organizations can employ uneducated workers unfamiliar with supply chain processes and adequate data protocols because of a lack of structured culture; for example, employees trained with the proper skillset will utilize their competency to seek work elsewhere and search for a greater income instead of remaining at their

current job and aptly training others. Transportation difficulties pervade the country as there are very few roads and little security throughout the country, resulting in untimely breakdowns in malaria commodity stock inputs. If the goods and supplies somehow do get delivered, it is "usually from the capital city distributed by air, which is expensive, just because the roads aren't passable" (Subject 3). Furthermore, the equatorial forest inhibits transit, financial inaccessibility demotivates the population and wages in many sectors outside of public health are insufficient and the lack of urbanization throughout the country leads to externalities that impede the management of the disease. While antimalarial commodities are heavily subsidized, they remain largely unaffordable to many Congolese. For example, "malaria prophylaxis is expensive and sometimes either some of the medicine you have to take is daily or some of the medicine is weekly. Combinations of Artisunot, one of the newer medicines, were just more expensive than what most people could afford" (Subject 3). Additionally, the antimalarial commodities may not be fully stocked in the public health facilities. All of these issues compound the Congolese people's resistance to seeking treatment, thus increasing transmission rates.

Using malaria prevention and treatment tools has allowed the current incidence of malaria to decline drastically down to just 25% (WHO, 2018). While the methods are available, a vast majority of the time they are inaccessible to the people. Some of the issues contributing to this gap between the available commodities and the end-recipients include: ignorance of the population to follow Ministry of Health guidelines, lack of funded means to access care, failure of repeat stocks, and the distance between the populations and the existing health structures. The DRC's financial self-sufficiency has been crippled by its reliance on foreign aid; this dependence on foreign funding, alongside the corruption starting at the national level, has not allowed the DRC to create and sustain enough capital to enact serious change in its fight against malaria. In

order to better understand the issues contributing to the DRC, the research team analyzed the aforementioned issues in both the literature review and the semantic analysis. The research team noted that the decline in malaria mortality has further complicated the Congolese people's desire to prevent malaria (Mavoko et al., 2015). Malaria in the DRC is viewed no differently than people view contracting the flu in the United States. Malaria is viewed as just a part of daily life. This mindset allows *plasmodium* to spread malaria to more vulnerable populations, as people do not seek treatment; it creates a resistance to the monotherapies, and results in a higher mortality rate (Gelband, Panosian, & Arrow, 2014). This is not to say that the Congolese people are unaware of the consequences of contracting malaria. In fact, the idea that they are uneducated in germ theory is completely erroneous.

Research Analysis and Inferences

These results validate what the research team uncovered during the literature review and allow the formulation of an alternative approach to eradicating malaria in the DRC that focuses on issues and factors that specifically impact the country. Although none of the aforementioned factors are specific to the DRC, the solution to reducing malaria-related mortality necessitates a DRC-centric approach. From the research key findings, we discovered that malaria is a systemic challenge comprised of self-sustaining issues, rather than solely a supply chain issue; meaning that if one attempted to fix the supply chain issue, it would do little to impact the rate of malaria mortality in the DRC.

We created the chart shown in Figure 8 indicating the systemic cyclical challenges in the DRC. The impoverished conditions in the country give rise to violence that in turn destabilizes effective government, rendering the government incapable of funding malaria aid. This reliance on foreign aid becomes ingrained in the country, weakening the culture and enabling poverty by inhibiting self-sufficiency. This is a departure from the traditionally held belief that malaria will be solved through the elimination of poverty and the use of antimalarial commodities and instead pinpoints five systemic issues that create a self-propelling cycle of malaria in the DRC. This study proposes that antimalarial commodities merely treat the symptoms of malaria; malaria can only be eradicated upon the elimination of the aforementioned five systemic issues.

Figure 8. Major structural factors contributing the current state of malaria.

In conclusion, we investigated the numerous issues inhibiting the effectiveness of the antimalarial supply chain in the DRC in order to identify the problems contributing to the state of malaria in the country. After analyzing the aforementioned research, a two-fold solution was suggested. It required a general understanding that one does not have to live a life influenced by malaria. Outside medical aid companies must treat malaria in a way the culture wants and that will end the compounded challenges inhibiting the malaria aid supply chain. The study *Malaria*

and Poverty published in the *New York Academy of Science* journal has demonstrated the connection between poverty and malaria (Teklehaimanot & Mejia, 2008). Aid organizations and DRC political leadership must direct their focus just as much on eliminating poverty as they do to eliminating malaria. The way forward is to stabilize the country, facilitate economic growth, and migrate the current malaria aid to provide citizens with alternative methods of payment for the preventative methods currently being distributed for free, to eradicate malaria. These methods could include a specified number of work hours or a small cash payment.

Over the last 10 years, the issues in the DRC have migrated from drug availability and malaria screening effectiveness to a systemic sociological and cultural issue that permeates each level of the health structure. This research study on the malaria commodity supply chain focuses on providing a holistic view of supply chain improvement amidst a series of economic, cultural, and infrastructural issues that greatly inhibit malaria aid in the country. Because this environment is so complex, the current method of supply chain design does not account for the majority of challenges and forces a repetitive data accumulation process. While this study utilizes and existing structure as the backbone of this research, it is specifically aimed at governmental aid challenges throughout Sub-Saharan Africa, not the DRC specifically. This research seeks to streamline humanitarian aid and improve the current approach by creating a detailed list of factors inhibiting the current success of cost-effective long-term malaria aid in the DRC.

After analyzing the qualitative research data, three major groups of issues inhibiting effective humanitarian aid emerged: cultural, political unrest, and socioeconomic challenges. Analyzing the first issue, culture, most people in the DRC are not concerned about the malaria and view it as simply a part of everyday life. Contracting malaria in the DRC is viewed no differently in the contracting the common cold is viewed in the United States. So, how

as researchers do you combat a multi-faceted issue that is not even recognized as a problem, given the challenging environment that exists in the DRC? Historically, foreign entities have had to act as the catalyst for change by pushing countries towards the realization that their view of normalcy can be improved. Given that global foreign malaria aid funding is at around 2 billion dollars, it is evident that foreign entities are more than willing to intervene in the operations of another nation underneath the banner of humanitarian aid (WHO, 2017). However, given the recent plateau of international funding for malaria aid we must learn how to maximize the spending power of that money (WHO, 2017).

In order to understand how to best maximize the spending power of that money, one must understand the interrelationship between the Congolese culture and its systemic poverty. The people work hard to create a life for themselves in an environment where money is scarce. As a result, they are more focused on their current conditions than they are the elimination of the disease they view as minor as the flu. This ultimately creates a short-term mentality and impairs a more long-term orientation.

A cyclical relationship between poverty and malaria exists in the DRC where 71% of the population lives below the poverty line, bringing us to our second major issue inhibiting malarial aid (World Bank, 2017). While aid organizations have focused on providing and subsidizing commodities to prevent and treat malaria, it is merely a symptom of a greater socio-economic issue. The mentality that antimalarial commodities will continue to be handed out for free creates a systematic reliance that detaches value from the antimalarial commodity. For example: because NGOs provide mosquito nets they do not want citizens to turn around and sell the nets; therefore, the government has made it illegal to sell treated bed nets. Not only does this not allow people to buy them when needed, it does not allow for in-country production. Although these antimalarial

commodity measures have resulted in substantial mortality reduction, to continue this upward trend aid must migrate from a platform of simply providing to stimulating in-country aid efforts and spearhead economic independence. This can be done by heavily subsidizing antimalarial commodities, providing funding to build insecticide-treated bed net factories, offering the commodities in exchange for a certain number of hours of work if the individual could not afford the cost. Ultimately, when value is attached to the item, it has the potential to motivate individuals to repair broken nets and increase usage and adoption of antimalarial commodities.

The current political state of the country and the final major issue hindering malarial aid significantly impact humanitarian aid efforts as corruption, bribery, and theft inhibit the dissemination of intact aid to the lower levels of the health structure. The political system is stuck in a seemingly endless cycle in which war and violence begets the government's lack of capacity to deal with such matters. In fact, while conducting interviews in January 2018 the current political situation escalated as current leadership again attempted to maintain power, resulting in violence and an internet shut down. The government is operated in such a way that the current ruling party is focused more on maintaining their own power than the restoration of the country at large. Without the aid of an overarching political strategy the parties in power act in their own self-interest and often undermine their own long-term role in the unstable political process. Soldiers are rarely paid on time, if at all, resulting in an armed force that constantly steals and loots to make ends meet - actions seen as an extension of the government. The dozens of armed militia groups claiming to fight for one cause or another ultimately results in a confusing string of violence that gives rise to a select powerful few and further exacerbates the efforts that many believe would give way to progress. Funding for malaria aid tends to go

"missing" periodically, an overreliance on external aid exists, and oftentimes the effectiveness of antimalarial drugs cannot be guaranteed as counterfeits are introduced into the supply chain.

In concluding, a cyclical relationship exists between the cultural, political, and socio-economic issues because the current mortality rate is the product of rampant poverty that stems from the cultural challenges of problem recognition and systematic reliance on foreign aid; this ultimately results in the historic pattern of political instability. Currently, utilizing the three main antimalarial commodities: insecticide-treated nets, ACTs, and residual spraying, are viewed as the solution to malaria. Although these methods greatly aid in decreasing malaria, perceivably malaria will only be eradicated upon the elimination of poverty by bolstering the country's ability to operate self-sufficiently through addressing the cultural and political challenges. In order to eradicate malaria, the DRC must increase the government's ability to enforce the law, provide education that leads to gainful employment, and incentivize political involvement through taxation – a method historically has resulted in a 28% percent increase compared to control groups (Weigel, 2017).

CHAPTER V

CONCLUSION

Study Conclusions

This study set out to ascertain the reasons contributing to the high number of malaria-related deaths and through a series of interviews discovered that 90% of the participants stated treatment and prevention methods were adequate to meet demand. This result prompts the question: Why is the rate of malaria mortality so high if the antimalarial commodities are sufficient to meet demand? While the methods are available, too often they are inaccessible to the people. Some of the issues contributing to this disparity between the available commodities and the end-recipients include ignorance of the population to follow the guidelines given by the DRC Ministry of Health, lack of funded means to access care, failure of repeat stocks, and the physical distance between those populations needing services and the existing health structures. Additionally, the few roads that exist remain in a state of disrepair, and electricity and cell reception are inaccessible in parts of the country. This makes transporting and predicting antimalarial stock out incredibly difficult. Politically, the DRC has a history of violence that has given rise to dozens of armed groups, leading to an unstable government incapable of attaining order. The government is more focused on maintaining power than improving the country at large. Historically, poverty is concomitant with malaria and creates a mentality of short-term gain instead of long-term orientation where people focus on their present state rather than their future well-being. This exacerbates the current in-country issues because those who have developed a resistance to *plasmodium* do not seek treatment and, instead, decide to live with malaria, expediting malaria transmission. Furthermore, the DRC does not have the capital to

fund necessary malaria aid; as such, it relies almost entirely on foreign aid. These foreign entities may place restrictions on the money and allocate it for a predetermined set of initiatives that may not align culturally with the DRC. The health structure struggles with corruption at every level as well as the dissemination of counterfeit medication. Interconnectivity between health structure layers is severely lacking. Communication disparities and dozens of concurrently-operating supply chains lead to stock-out issues, a lack of historical use data, and increased cost of providing aid.

From the research key findings, the team discovered that malaria is a systemic challenge comprised of self-sustaining issues rather than, solely, a supply chain issue. An endeavor to fix the supply chain issue would be inefficacious in decreasing the rate of malaria mortality in the DRC. The team created Figure 9, indicating that the more evident challenges in the DRC are ultimately caused by systemic issues that may not be clearly identified initially.

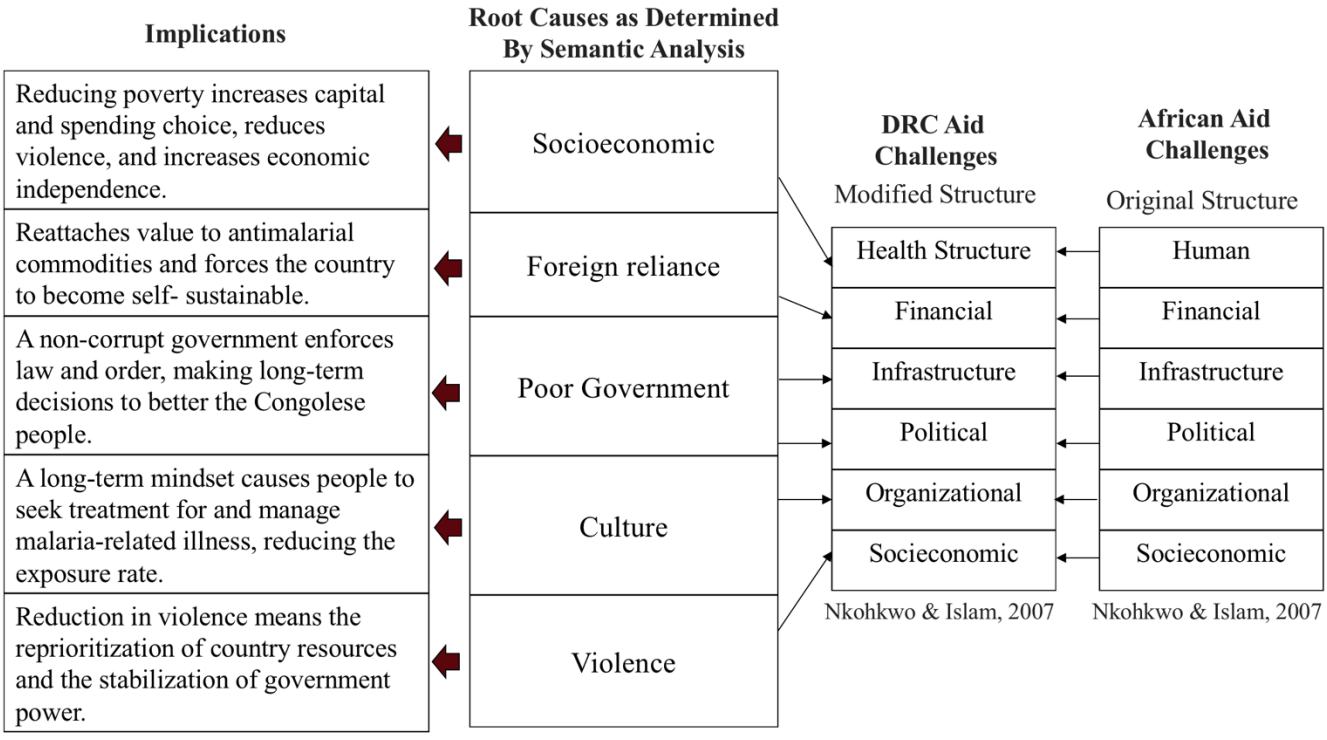

Figure 9. Root cause analysis of the causal factors of malaria.

Figure 9 was created using a modified structure based off of Nkohkwo and Islam's research on the aid challenges in Sub-Saharan Africa. Then, after verifying that these problems accurately represented the issues in the DRC the researchers conducted a semantic analysis to determine the root causes of these issues. From the semantic analysis five root causes were identified: socioeconomic, foreign reliance, poor government, culture, and violence. This study only identified the root causes and did not analyze the degree to which they effect the transit of antimalarial commodities. Furthermore, this study did not analyze which aspects of the DRC were affected specifically by each of the five root causes.

The DRC's impoverished conditions engender violence that, in turn, destabilizes effective government, and renders the government incapable of funding malaria aid. This reliance on foreign aid becomes ingrained in the country and weakens the culture, promoting poverty by inhibiting self-sufficiency. This is a departure from the traditionally-held belief that malaria will be solved through the elimination of poverty and the use of antimalarial commodities and, instead, pinpoints five systemic issues – socioeconomic turmoil, foreign reliance, poor government, cultural issues, and violence – that create a self-propelling cycle of malaria in the DRC. This study proposes that antimalarial commodities merely treat the symptoms of malaria, and malaria can only be eliminated by addressing these five systemic issues.

Although the current approach to eliminating malaria focuses on poverty, this remains extremely difficult to combat in malaria-pervasive locations because poverty is often concomitant with malaria because malaria magnifies the negative impact of disease and related conditions. To eliminate poverty, humanitarian aid must migrate from a platform of simply providing to stimulating in-country aid efforts and instead spearhead economic independence.

This can be done by heavily subsidizing antimalarial commodities, enabling in-country production, and offering the commodities in exchange for an alternative form of payment if an individual cannot afford the cost. Ultimately, when value is attached to any item or service, usage and adoption of antimalarial commodities can potentially increase. The mentality that antimalarial commodities will continue to be given at no cost creates a systematic reliance: detaching value from the commodity. For example, the government has made it illegal to sell insecticide-treated mosquito bed nets because it does not want citizens to turn around and sell the cost-free nets provided by aid organizations. Not only does this prevent people from buying the nets when needed, it inhibits in-country production. Malaria is a systemic societal problem from which a supply chain issue is created, meaning that if the supply chain issue were to be eliminated, malaria-related mortality would hardly be impacted. The current mortality rate is a consequence of the combined issues (see Figure 9), and in order to break the cycle, we must begin to eliminate these systemic issues. When one of the issues is eliminated, the rest become infinitely easier to tackle. What would this approach look like? Helping the Congolese people adopt a long-term mindset by expanding their understanding of normalcy – a life without malaria – can heighten resolve and induce the citizens to seek and manage malaria-related illness thereby reducing the exposure rate. Mitigating violence has great potential to stabilize governmental power and lead to a reprioritization of the country's resources. Furthermore, reducing poverty can create prosperity by allowing the Congolese people spending choice leading to increased economic independence and reductions in violence. These actions would ultimately reattach value to antimalarial commodities and enables the country to become self-sufficient. Finally, a non-corrupt government possesses an increased ability to enforce law and order, enhancing their ability to make long-term decisions to better the Congolese people.

Summary of Study Significance

This study is significant because the DRC encompasses 10% of the approximate 407,000 annual malaria-related deaths in Sub-Saharan Africa (WHO, 2017). Factors such as lack of infrastructure and socio-economic turmoil impair malaria prevention and treatment access and, consequently, result in high levels of mortality leading to economic repercussions including reductions in working time, loss of productivity, and reduced family income. Currently, aid organizations focus on supply chain improvement to move antimalarial commodities, items that assist in the prevention and treatment of malaria, to desired locations when required. However, this current method of supply chain design does not account for the majority of DRC-centric challenges; failure to focus on the holistic spectrum of issues has resulted in a narrowly-focused methodology that ultimately hinders effective aid. These issues are critical to understand because malaria-related mortality is entirely preventable and impairs the industrialization of the DRC.

Not only are approximately 32% of outpatient visits directly attributable to malaria in the DRC, but 36% of deaths are caused by malaria-related illness (PMI, 2017). A mere 30% of Congolese have access to medical aid; furthermore, the dearth of accessible health care precipitates these entirely preventable deaths (USAID, 2018). Mainstream opinion suggests that through the continued donations of antimalarial commodities and the eventual elimination of poverty in the DRC, the issue of malaria will be effectively resolved (Teklehaimanot & Mejia, 2008). However, this model remains unrealistic. Poverty is too large an issue to readily combat because it is the result of larger socioeconomic and political issues. Antimalarial commodities are effective and have led to the drastic decline Antimalarial commodities are effective and have led to the drastic decline – from 52.5% in 2005 to just 24.6% in 2015 – in the incidence of malaria in the DRC (WHO, 2018). However, the decline in malaria mortality has further

complicated the Congolese people's desire to prevent malaria. A factor contributing to this complication is that malaria in the DRC is viewed as part of everyday life, no differently than we view contracting the flu in the United States. This mindset allows *plasmodium* to spread malaria to more vulnerable populations, as people do not seek treatment; creates a resistance to the monotherapies; and results in a higher mortality rate. This research seeks to identify the causal factors inhibiting the current success of cost-effective, long-term malaria aid in the DRC while focusing on the distribution of effective aid in order to redefine the root causes of challenges as it relates to malaria aid.

In concluding, this approach moves the current approach to combating malaria-related mortality from a mindset that forces an overreliance on external aid and cripples the country's ability to become self-sufficient to one that focuses on increasing the country's ability to become self-sufficient. Although antimalarial commodities contribute to the decline of malaria, perceivably malaria in the DRC will only be eradicated upon the elimination of the country's societal challenges. The aforementioned approach in Figure 9 allows a more holistic approach to combating malaria and incorporates an integrated view of supply chain in conjunction with socioeconomic, cultural, and political issues. However, in order to fully eradicate malaria, the DRC should incentivize political involvement through taxation which has demonstrated a 28% increase in involvement when compared to control groups (WHO, 2018) Such governments beget the capability of enforcing law, providing education, promoting gainful employment, and, ultimately, reducing reliance on foreign aid. When the Congolese people reprioritize malaria as a significant systemic issue and begin to target the operational inefficiencies that exist in the DRC, the more than 40,000 completely preventable malaria-related deaths annually will drastically decline (WHO, 2017). This decrease in unnecessary death will allow the DRC to become a more

industrialized nation capable of regulating its mineral use and minimizing future exploitation of its resources, ultimately bettering the Congolese people by increasing the country's stability and presence on the international stage.

Study Strengths and Limitations

This study presents an approach to combating malaria mortality, one that combines previous cultural and sociological research with supply chain initiatives focused on both malaria prevention and treatment efforts. It migrates the topic from an issue of poverty to a systemic societal issue in which the antimalarial commodities – even when easily accessible – are not utilized to maximize the effect of the humanitarian aid efforts.

This study contains limitations derived from a small research population, resulting in perspectives skewed towards doctors and health workers than those involved directly with the humanitarian aid efforts. Additionally, government employees were not represented in the research population. Furthermore, this study focused on the strategy of combating malaria mortality and fails to provide detailed tactical steps to accomplishing the broad series of goals contained within this study. Because the on the ground situation in the DRC is constantly changing the study only factored in the last fifteen years of malaria-related initiatives. This number was chosen based off of historic research and interviews with the research population; however, this number cannot be tied to a specific clear cut-off point.

Recommendations for Practice, Policy, and Future Areas of Research

Although antimalarial commodities contribute to the decline of malaria, perceivably it will only be eradicated upon the elimination of the DRC's societal challenges. This study concluded that malaria is a systemic societal problem from which a supply chain issue is created. In order to eliminate, or at least decrease, the current malaria-related mortality in the DRC aid

organizations should focus on the following five initiatives: They should migrate the Congolese people's mindset towards a long-term mindset, causing the people to seek and manage malaria related illness thereby reducing the exposure rate. Second, reductions in violence can lead to the reprioritization of country resources and the stabilization of government power. Third, reducing poverty can create prosperity and allow people excess spending capital. When the consumer has the power to choose their living conditions and working environment through their contributions to the economy, it can mean reduced violence and lead to a more independent DRC. Fourth, migrating aid in the DRC to one which necessitates work or a fee with antimalarial commodities reattaches value to the commodities. Developing production facilities for these commodities forces the country to become self-sufficient and less reliant on foreign entities. Lastly, a non-corrupt government can better enforce law and order and make long-term decisions to better the Congolese people.

The semantic analysis conducted within this study concluded that the country should increase indoor spraying with insecticide applications. This has the potential to reduce the number of mosquitoes living near or in houses. The population should be grouped into group health insurance plans that will ensure appropriate and affordable medical care for the country as a whole. In order to boost economic growth, the Congolese government should initiate mini-projects with income-generating activities that will provide farmers with income they can utilize to gain access to appropriate healthcare. Additionally, a new incentive system for healthcare providers should be implemented that includes incentive bonuses because the salary provided by the state is much lower than necessary. The DRC remains in desperate need of improved road and safety conditions. These improvements would better facilitate internal movement in the country and easier antimalarial commodity shipment methods. In order to filly eradicate malaria

the DRC they must incentivize political involvement through taxation which will lead to the installation of a non-corrupt government capable of enforcing the law and providing education that leads to gainful employment, and ultimately reducing their reliance on foreign aid.

Currently, multiple initiatives are in place within the DRC focusing specifically on enhancing both the physical and the information supply chains. The current situation in the DRC necessitates a regular supply of medicines and prevention inputs to health centers and clinics across the country. Increasing public awareness and incentivizing community-wise behavioral changes in regard to seeking treatment and understanding the need for treatment remains necessary. Research should be conducted into raising public awareness for both the use of mosquito nets and environmental sanitation. Furthermore, new methods of incentivizing people to immediately use a rapid diagnostic test once they begin to feel the early-onset of a fever. Additionally, future research should also include improved laboratory and medicinal usage information. This remains an incredibly important and under-researched topic as laboratory reagents for microscopy and medicine quantities are incredibly necessary for the treatment of severe malaria cases, especially when one considers the high RDT rate of false negatives. Finally, further investment and investigation into integrated vector management has the potential to reduce *plasmodium* prevalence in the DRC. This area of control assists with community involvement with malaria controls, ultimately providing a more holistic approach to malaria prevention and treatment (Chanda, 2016).

REFERENCES

Adeya, G., Bukasa, G., & Tomsej, X. (2009). *Assessing the Procurement, Distribution, and System-Strengthening Needs for the Pharmaceutical System in the Democratic Republic of the Congo*. Arlington, VA: Management Sciences for Health. Retrieved from http://pdf.usaid.gov/pdf_docs/Pnadp037.pdf

Canada: Immigration and Refugee Board of Canada. (2012). *Democratic Republic of Congo: Mobility and methods of transportation between Grand Kivu and Kinshasa*. Retrieved from http://www.refworld.org/docid/4f9e5f742.html

Chanda, E. (2016). Exploiting the potential of integrated vector management for combating malaria in Africa. *Current Topics in Malaria*. InTech, doi: 10.5772/65457

Clowes, W. (2017). *Briefing: The conflict in Kasai, DRC*. Retrieved from https://www.irinnews.org/analysis/2017/07/31/briefing-conflict-kasai-drc

Coghlan, B., Ngoy, P., Mulumba, F., Hardy, C., Bemo, V. N., Stewart, T., … Brennan, R. J. (2009). Update on mortality in the Democratic Republic of Congo: Results from a third nationwide survey. *Disaster Medicine and Public Health Preparedness, 3*(2), 88-96. doi: 10.1097/DMP.0b013e3181a6e952.

Council on Foreign Relations. (2018) *Violence in the Democratic Republic of Congo.* Retrieved from https://www.cfr.org/interactives/global-conflict-tracker#!/conflict/violence-in-the-democratic-republic-of-congo

David, J. (2018, March 8). WFP's immediate response account - saving lives in the Kasai region of DRC. *World Food Programme Insight*. Retrieved from https://insight.wfp.org/wfps-immediate-response-account-saving-lives-in-the-kasai region-of-drc-b029bdb4e5af

Doumbia, S., Clark, A., & Mwansasu, A. (n.d.) Defeating Malaria through pharmaceutical systems strengthening. *Systems for Improved Access to Pharmaceutical Services Program*. Arlington, VA. Retrieved from http://siapsprogram.org/wp-content/uploads/2017/07/Defeating-Malaria.pdf

Donnelly, M. J., McCall, P. J., Lengeler, C., Bates, I., D'Alessandro, U., Barnish, G., … Mutero, C. (2005). Malaria and urbanization in sub-Saharan Africa. *Malaria Journal, 4*(1), 12. doi: 10.1186/1475-2875-4-12.

Gelband, H., Panosian, C. B., & Arrow, K. J. (Eds.). (2004). *Saving Lives, Buying Time: Economics of Malaria Drugs in an Age of Resistance*. Washington (DC), District of Columbia: National Academies Press. doi: 10.17226/11017.

Griffin, J. T., Hollingsworth, T. D., Okell, L. C., Churcher, T. S., White, M., Hinsley, W., … Ghani, A. C. (2010). Reducing plasmodium falciparum malaria transmission in Africa: A model-based evaluation of intervention strategies. *PLoS Medicine, 10*(7), 8. doi: 10.1371/journal.pmed.1000324.

Guyant, P., Corbel, V., Guerin, P. J., Lautissier, A., Nosten, F., Boyer, S., … White, N. (2015). Past and new challenges for malaria control and elimination: The role of operational research for innovation in designing interventions. *Malaria Journal, 14*, 279. doi: 10.1186/s12936-015-0802-4.

Human Rights Watch. (2017). *World Report's Democratic Republic of Congo*. Retrieved from https://www.hrw.org/world-report/2017/country-chapters/democratic-republic-congo

Ilunga, H. K., Likwela, J. L., Ntuku, H., Julo-Reminiac, J. E., O'Reilly, L., Kalemwa, D., … Snow, R. W. **(**2014). *An Epidemiological Profile of Malaria in the Democratic Republic of Congo*. United Kingdom: The Department for International Development. Retrieved from http://www.inform-malaria.org/wp-content/uploads/2015/03/DRC-Epidemiological-Report-120914.pdf

International Crisis Group. (2017). *Time for Concerted Action in DRC Congo.* Retrieved from https://www.crisisgroup.org/africa/central-africa/democratic-republic-congo/257-time-concerted-action-dr-congo

Lorenson, K. & Mvundura, M. (2013). Delivering Vaccines: A cost comparison of in-country vaccine transport container options. *Optimize*. Seattle, WA: PATH, World Health Organization. Retrieved from https://www.path.org/publications/files/TS_opt_in_country_transport_rpt.pdf

Mvumbi, D. M., Bobanga, T. L., Melin, P., DeMol, P., Kayembe, J. N., Situakibanza, H. N., Hayette, M. P. (2016). High prevalence of plasmodium falciparum infection in

asymptomatic individuals from the Democratic Republic of the Congo. *Malaria Research and Treatment, 16*. doi: 10.13140/RG.2.1.3437.4006.

Mavoko, H. M., Ilombe, G., daLuz, R. I., Kutekemeni, A., VanGeertruyden, J. P., & Lutumba, P. (2015). Malaria policies versus practices, a reality check from Kinshasa, the capital of the Democratic Republic of Congo. *BMC Public Health, 15*, 352. doi: 10.1186/s12889-015-1670-0.

Mikkelsen-Lopez, I., Shango, W., Barrington, J., Ziegler, R., & Smith, T. (2014). The challenge to avoid anti-malarial medicine stock-outs in an era of funding partners: the case of Tanzania. *Malaria journal, 13*(1), 181. doi: 10.1186/1475-2875-13-181.

Molla, E. (2016). Malaria: What are the needs for diagnosis, treatment and control? *Biology and Medicine, 8*, 320. doi: 10.4172/0974-8369.1000320.

Mpanya, G., Tshefu, A., & Likwela, J. L. (2017). The malaria testing and treatment market in Kinshasa, Democratic Republic of the Congo. *Malaria Journal, 16*, 94. doi: 10.1186/s12936-016-1659-x.

Mwenesi, H.A. (2005). Social science research in malaria prevention, management and control in the last two decades: An overview. *Acta Tropica, 95*(3), 292-297. doi: 10.1016/j.actatropica.2005.06.004.

Newton, P. N., Green, M. D., & Fernández, F. M. (2010). Impact of poor-quality medicines in the 'developing'world. *Trends in Pharmacological Sciences, 31*(3), 99-101.

Nkohkwo, Q. N., & Islam, M. S. (2013). Challenges to the Successful Implementation of e-Government Initiatives in Sub-Saharan Africa: A Literature Review. *Electronic Journal of e-Government, 11*(1), 252-266. Retrieved from http://www.ejeg.com/volume11/issue1/p252

Owens, S. (2015). Malaria and the Millennium Development Goals. *BMJ Journals, 100*(1), s53-s56. doi: 10.1136/archdischild-2013-305441.

Pan African Medical Journal (PAMJ), (2016). *Better Health through Knowledge Sharing and Information Disseminatio*. Retrieved from panafrican-med journal.com/content/References.php?Src=Art&ManNum=24-94

Pariona, A. (2016, August 05). Countries with the highest rates of malaria. Retrieved April 06, 2018, from https://www.worldatlas.com/articles/countries-with-the-highest-rates-ofmalaria.html

PricewaterhouseCoopers. (2018). *Democratic Republic of the Congo.* Retrieved from https://www.pwc.com/gx/en/transportation-logistics/publications/africa-infrastructure-investment/assets/drc.pdf

RFI. (2016, July 26). RDC: Affrontements entre la police et des taxis-motos à Kisangani. Retrieved April 07, 2018, from http://www.rfi.fr/afrique/20160726-rdc-affrontements entre-police-taxis-motos-kisangani

Rosen, A. (2013). *The Origins of War in the DRC*. Retrieved from https://www.theatlantic.com/international/archive/2013/06/the-origins-of-war-in-the-drc/277131/

Roser, M. & Ritchie, H. (2015). *Malaria*. Retrieved from https://ourworldindata.org/malaria

SIAPS, SCMS, IHP, & USAID. (2014). *DRC LMIS Assessment.* Arlington, VA: Management Sciences for Health. Retrieved from http://apps.who.int/medicinedocs/documents/s21995en/s21995en.pdf

Swana, E. K., Makan, G. Y., Mukeng, C. K., Mupumba, H. I., Kalaba, G. M., Luboya, O. N., & Bangs, M. J. (2016). Feasibility and implementation of community-based malaria case management with integrated vector control in the Democratic Republic of Congo. *Malaria Journal, 15*(1), 413. doi: 10.1186/s12936-016-1475-3.

Teklehaimanot, A. & Mejia, P. (2008). Malaria and poverty. *Annals of the New York Academy of Sciences, 1136*(1), 32-37. doi: 10.1196/annals.1425.037.

Trustfall, P. (2015). Democratic Republic of the Congo becomes Africa's Unexpected Success Story. *World Finance: The Voice of the Market*. Retrieved from https://www.worldfinance.com/infrastructure-investment/democratic-republic-of-congo-becomes-africas-unexpected-success-story

USAID. (2018a). Health Fact Sheet Democratic Republic of the Congo. U.S. Agency for International Development. Retrieved from https://www.usaid.gov/democratic-republic-congo/fact-sheets/usaiddrc-fact-sheet-health.

USAID. (2014). Supply Chain Management Systems for Improved Access to Pharmaceuticals and Service System Integrated Health Project *DRC LMIS Assessment*. Arlington, VA: Management Sciences for Health. Retrieved from http://apps.who.int/medicinedocs/documents/s21995en/s21995en.pdf

USAID. U.S. Malaria Operational Plan FY 2017. (2017). Retrieved from https://www.pmi.gov/docs/default-source/default-document-library/malaria-operational-plans/fy17/fy-2017-democratic-republic-of-congo-malaria-operational-plan.pdf?sfvrsn=19

USAID. U.S. Malaria Operational Plan FY 2018. (2018b). Retrieved from https://www.pmi.gov/docs/default-source/default-document-library/malaria-operational-plans/fy-2018/fy-2018-democratic-republic-of-the-congo-malaria-operational-plan.pdf?sfvrsn=5

Village Reach. (2015). *Exploring New Distribution Models for Vaccines and other Health Commodities Adapted to the on the Ground Realities of the Equateur and Tshuapa Provinces, Democratic Republic of Congo.* Seattle, WA. Retrieved from http://www.villagereach.org/wp-content/uploads/2015/11/DRC-Supply-Chain-Assessment-FINAL-English-version.pdf

Walker, K., & Lynch, M. (2007). Contributions of Anopheles larval control to malaria suppression in tropical Africa: review of achievements and potential. *Medical and veterinary entomology*, *21*(1), 2-21.

World Bank. (2017). *The World Bank in DRC.* Retrieved from http://www.worldbank.org/en/country/drc/overview

Weigel, J. (2017, November 20). No participation without taxation? Evidence from randomized tax collection in the D.R. Congo. Retrieved from https://blogs.worldbank.org/impactevaluations/no-participation-without-taxation-evidence-randomized-tax-collection-dr-congo-guest-post-jonathan

World Health Organization, Programme National d'Approvisionnement en Médicaments essentiels. (2009). *Cartographie des Systèmes d'Approvisionnement et de Distribution des Médicaments et Autres Produits de Santé en RDC*. Retrieved from: http://apps.who.int/medicinedocs/documents/s17032f/s17032f.pdf

World Health Organization. (2016). *Democratic Republic of Congo Epidemiological Profile.* Retrieved from http://www.who.int/malaria/publications/country-profiles/profile_cod_en.pdf

World Health Organization. (2017). *World Malaria Report 2017*. Retrieved from http://apps.who.int/iris/bitstream/10665/259492/1/9789241565523-eng.pdf?ua=1

World Health Organization. (2018). *Incidence of Malaria in the Democratic Republic of the Congo*. Retrieved from https://data.worldbank.org/indicator/SH.MLR.INCD.P3?locations=CD.

APPENDIX A

INTERVIEW QUESTIONS IN ENGLISH

1. List and describe your experience and number of year involved in the DRC.
2. What is the current state or impact of malaria within the Congo?
3. Are many people being impacted by malaria?
4. Is enough being done to prevent and treat malaria within the DRC at a country, local, and individual level?
5. Do you think that enough is being done for the physical distribution of preventative or treatment efforts?
6. If enough isn't being done, what indicators suggest that these are not going well?
7. What can we do in those areas to be more impactful and effective at combating malaria?
8. What factors do you think are contributing to these inefficiencies of access to malaria aid for the Congolese people?
9. Of all these factors, are any of these unique to the DRC?
10. What malaria treatment and prevention efforts are you aware of within the country that are effective at lowering the malaria rate within the DRC?
11. Can you name the best practices in this field of minimizing cost and efficiently transporting aid to the areas of the country that need it?
12. Do locals care about preventing malaria and if so, what steps do they take?
13. What do you think are other challenges and priorities that need to be addressed or improved on in order to alleviate the current state of malaria?
14. Are enough treatment and prevention methods available in the country to efficiently combat malaria?
15. If there are not, what can be done to increase the prevention and treatment methods available or their efficiency?
16. If there are, are they accessible to the people?
17. Why or why not?
18. Are the people using it?
19. If the people are not using the prevention and/or treatment methods, what are the challenges that coincide that issue?
20. Are there any important factors that I have not asked you about or you would like to expand upon?

APPENDIX B

INTERVIEW QUESTIONS IN FRENCH

1. Listez et décrivez votre expérience et nombre d'années passées en RDC (République Démocratique du Congo).
2. Quelle est la situation courante concernant la Malaria au Congo et quel en est l'impact?
3. Beaucoup de personnes souffrent-elles de la malaria?
4. Les mesures nécessaires pour prévenir et guérir la malaria au Congo sont-elles prises au niveau national, régional et individuel?
5. Pensez-vous que les moyens déployés pour la distribution physique de traitements préventifs ou curatifs sont suffisants?
6. Si les moyens déployés ne sont pas suffisants, quels sont les indicateurs permettant d'évaluer cette situation?
7. Que peut-on faire dans ces régions pour aider à combattre la Malaria?
8. Selon vous, quels sont les facteurs qui contribuent à cette difficulté pour les congolais d'accéder aux traitements de la Malaria?
9. Parmis ces causes, est-ce qu'il y en a qui sont unique au RDC ?
10. Quels traitements ou préventifs de la Malaria en RDC sont à ce jour efficaces pour diminuer le taux de personnes atteintes?
11. Pouvez-vous citer les solutions les plus efficaces pour la diminution des coûts et le transport d'aide aux pays concernés?
12. Les habitants locaux se soucient-ils de prévenir la Malaria et quelles étapes suivent-ils?
13. Selon vous, quels sont les autres défis et priorités dont il faut s'occuper afin d'améliorer la situation de la Malaria?
14. Les préventifs et traitements nécessaires sont-ils disponibles dans le pays pour combattre efficacement la Malaria?
15. Si non, que peut-on faire pour améliorer la disponibilité des traitements et préventifs dans le pays?
16. Si oui, sont-ils disponibles pour la population?
17. Pourquoi ou pourquoi pas?
18. La population les use-t'elle?
19. Si la population n'utilise pas les traitements et préventifs, quels sont les défis qui coincident avec cette situation?
20. Voudriez vous mentionner d'autres facteurs à propos desquels je ne vous ai pas questionné?